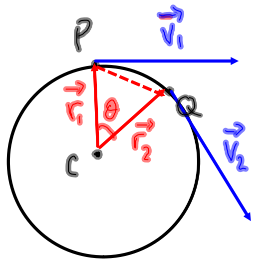
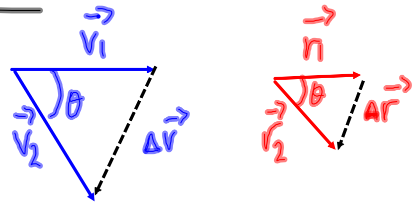
§11-2 Uniform Circular Motion





Using similar triangles

$|\Delta\vec{r}| = \Delta r \quad |\Delta\vec{v}| = \Delta v$

$|\vec{r}_1| = |\vec{r}_2| = r \quad |\vec{v}_1| = |\vec{v}_2| = v$

$$\frac{\Delta r}{r} = \frac{\Delta v}{v}$$

The distance actually travelled:

$$\Delta d = v\Delta t$$

But as $\Delta t \to 0$, $\Delta d \to \Delta r$

$$\frac{v\Delta t}{r} = \frac{\Delta v}{v}$$

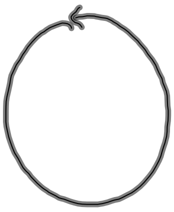
$$\frac{v^2}{r} = \frac{\Delta v}{\Delta t}$$

centre-seeking

Centripetal acceleration (magnitude only)

$$a_c = \frac{v^2}{r}$$

Dir ⇒ always to the centre of the curved path.



$\Delta d = 2\pi r$

$\Delta t = T$

$$v = \frac{\Delta d}{\Delta t}$$

$$v = \frac{2\pi r}{T}$$

← tangential velocity

$$a_c = \frac{v^2}{r}$$

$$a_c = \frac{\left(\frac{2\pi r}{T}\right)^2}{r}$$

$$a_c = \frac{4\pi^2 r^2}{T^2 r}$$

$$T = \frac{1}{f}$$

$$a_c = \frac{4\pi^2 r}{T^2} = 4\pi^2 r f^2$$

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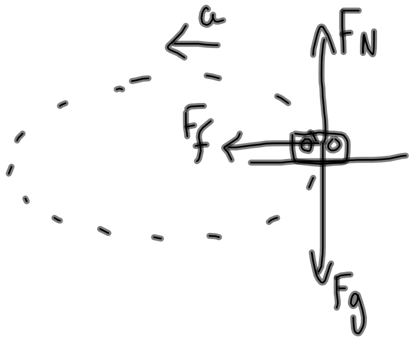
$m = 2135\ kg$

$r = 52\ m$

$\mu = 0.70$

$v_{max} = ?$



$\vec{F}_{net} = m\vec{a}$

$F_f = m\frac{v^2}{r}$

$\mu F_N = \frac{mv^2}{r}$

$\mu \cancel{m} g = \frac{\cancel{m} v^2}{r}$

$v^2 = \mu g r$

$v = \sqrt{(0.70)(9.81\ m/s^2)(52m)}$

$v = 19\ m/s$

If you go faster than 19m/s, you will go off the curved path

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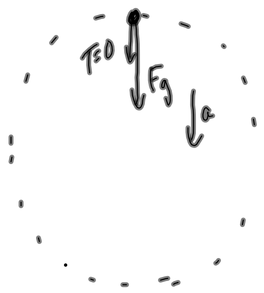
$m = 225g$

$r = 1.2m$

a) $V_{min} = ?$

b) $T_{side} = ?$

$T_{bottom} = ?$



At the minimum speed, T=0

$\vec{F}_{net} = m\vec{a}$

$F_g = m\frac{v^2}{r}$

$\cancel{m}g = \cancel{m}\frac{v^2}{r}$

$v^2 = gr$

$v^2 = (9.81 m/s^2)(1.2m)$

$v \doteq 3.4 m/s$

If you twirl the yo-yo slower than this you cannot complete the loop. If you twirl faster, the string will have tension.

b) at the side:

$\vec{F}_{net} = m\vec{a}$

$T = m\frac{v^2}{r}$

$T = \frac{(0.225kg)(3.4m/s)^2}{1.2m}$

$T \doteq 2.2N$

at the bottom:

$\vec{F}_{net} = m\vec{a}$

$T - F_g = \frac{mv^2}{r}$

$T = \frac{mv^2}{r} + F_g$

$T = 2.2N + (0.225kg)(9.81 m/s^2)$

$T = 2.2N + 2.2N$

$T \doteq 4.4N$

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